

The National Geographic Magazine

AN ILLUSTRATED MONTHLY



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A Washington player has at length invented and put upon the market at a very low price a little device which admirably fulfills the purpose, and at the same time serves as a pretty and useful table ornament, mirror, and pen-and-pencil rest. It is called the "Cosmos Scoreboard," and consists of a little polished wood tablet with a metal heavy-board that can be clamped down on the score in such a way as to bring a little metal plate over the squares in the "score" column of the card, for use in concealing each final score on each an unopened and unclipped as it is played in duplicate whist or the other series listed (in compass whist).

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	D U P L I C A T E		W H I S T			
	SCORE	TOTALS	TRUMP	OPPONENTS		
1					1	
2					2	
3					3	
4					4	
5					5	
6					6	
7					7	
8					8	
9					9	
10					10	
11					11	
12					12	
13					13	
14					14	
15					15	
16					16	
17					17	
18					18	
19					19	
20					20	
21					21	
22					22	
23					23	
24					24	
TOTALS				TOTALS		

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National Geographic Magazine

Vol. VII

SUMMER, 1891

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THE GREAT LAKES
MOVEMENT*

By G. K. COOPER
U. S. Geodetic Survey

The story of the Great Lakes practically begins with their

formation by glacial action. A great stream from the Erie basin crossed the

Home to the Mohawk Valley

formed by the waves. Several of those sand-lines have been

* Published by permission of the Director of the United States Geodetic Survey.

on or surfaces they must originally have been level, and their

opposite shore-lines are not exactly parallel, and their elevations vary from place to place, ranging from a few inches to three or four feet in the same

This wave formed one at a time, and the first to appear was in the Erie basin. It was much smaller than the modern lake, because the basin was then comparatively low at the northeast. Its outline is, unfortunately, unknown by the author, except his sketch of the one in passing map. Instead of receding from the site

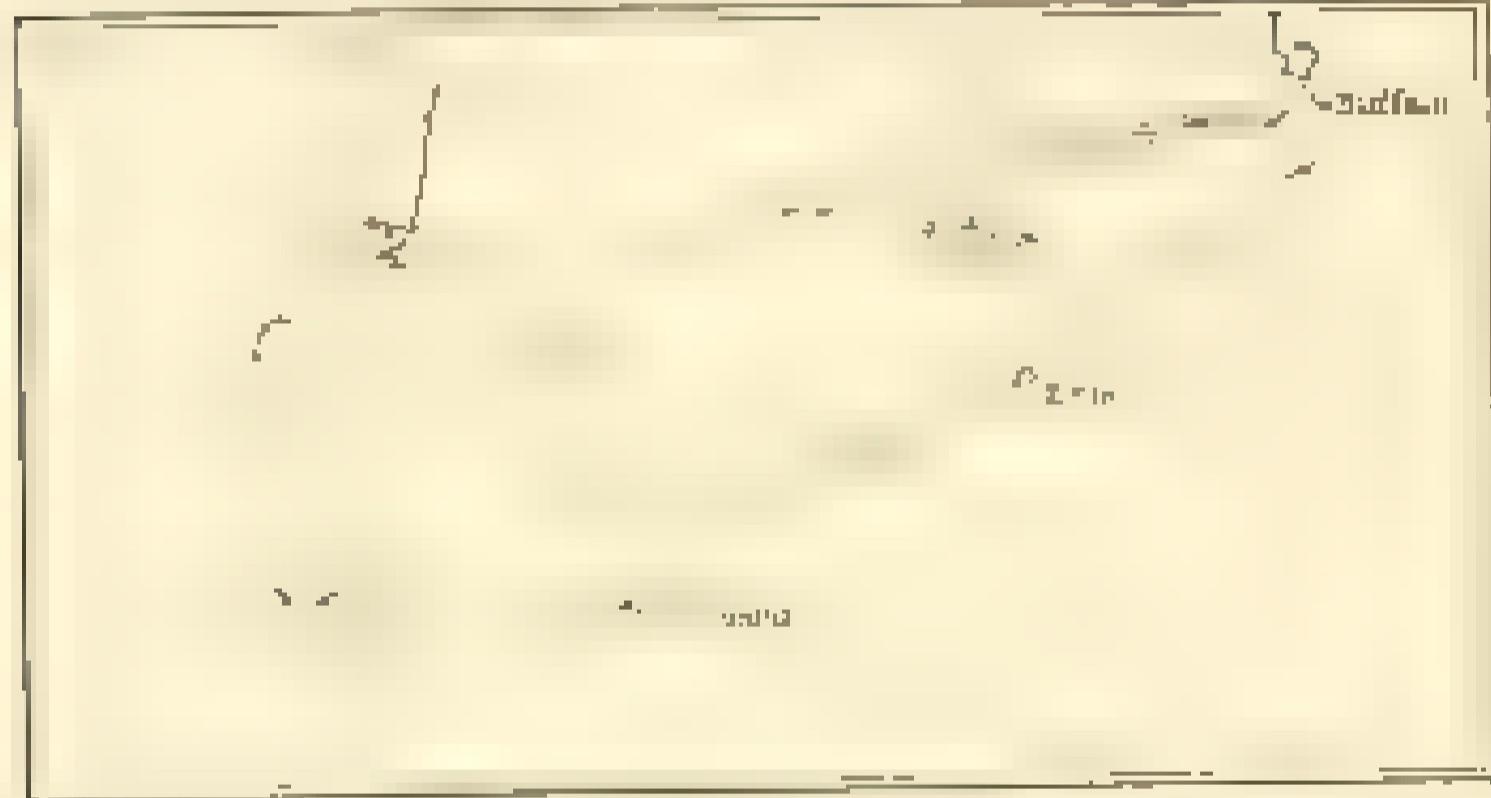


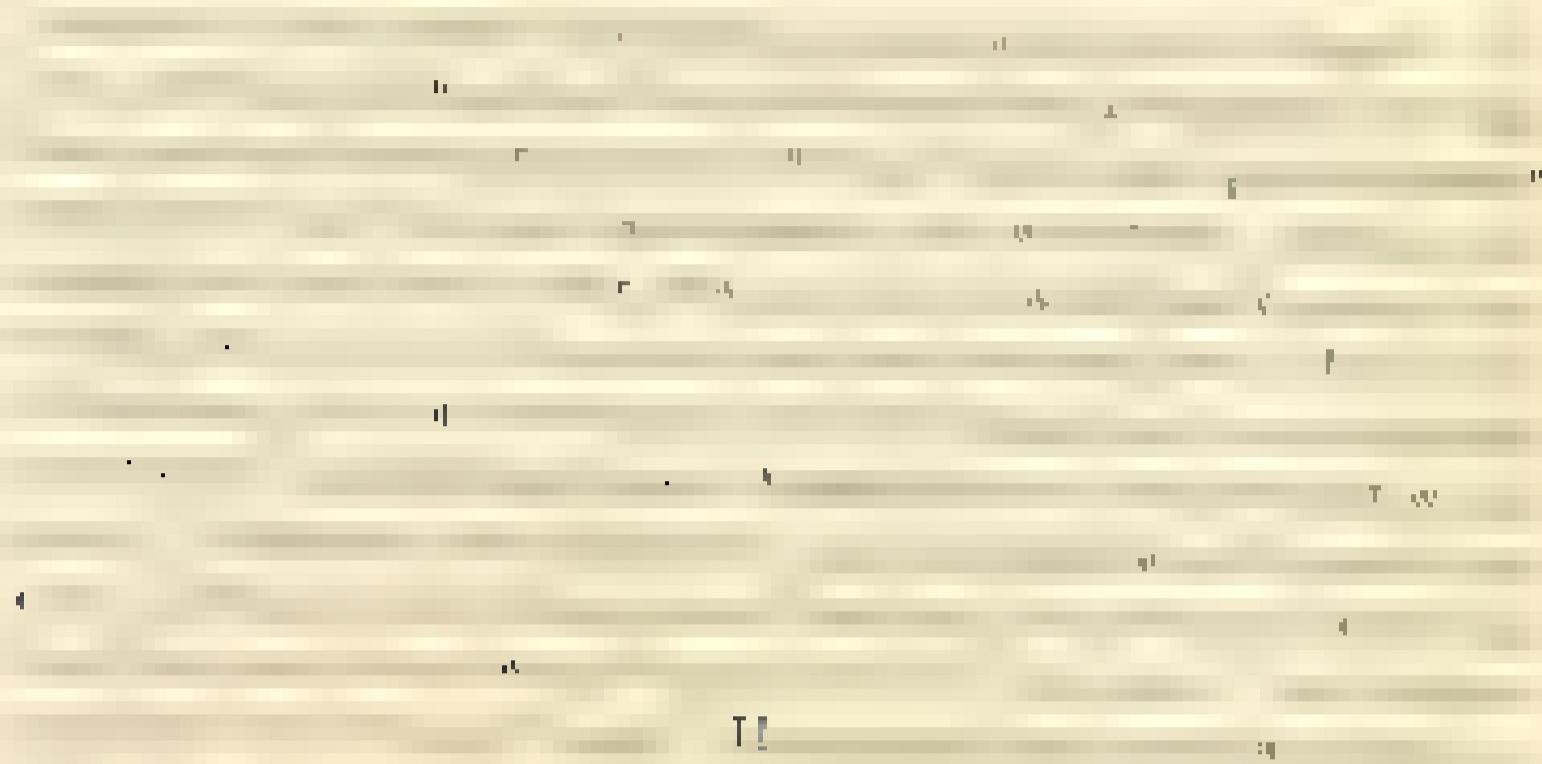
FIG. 2.—SKETCH AND MODERN OUTLINE OF BAY 2.

The broken lines show the positions of the shores at two epochs of the wave history

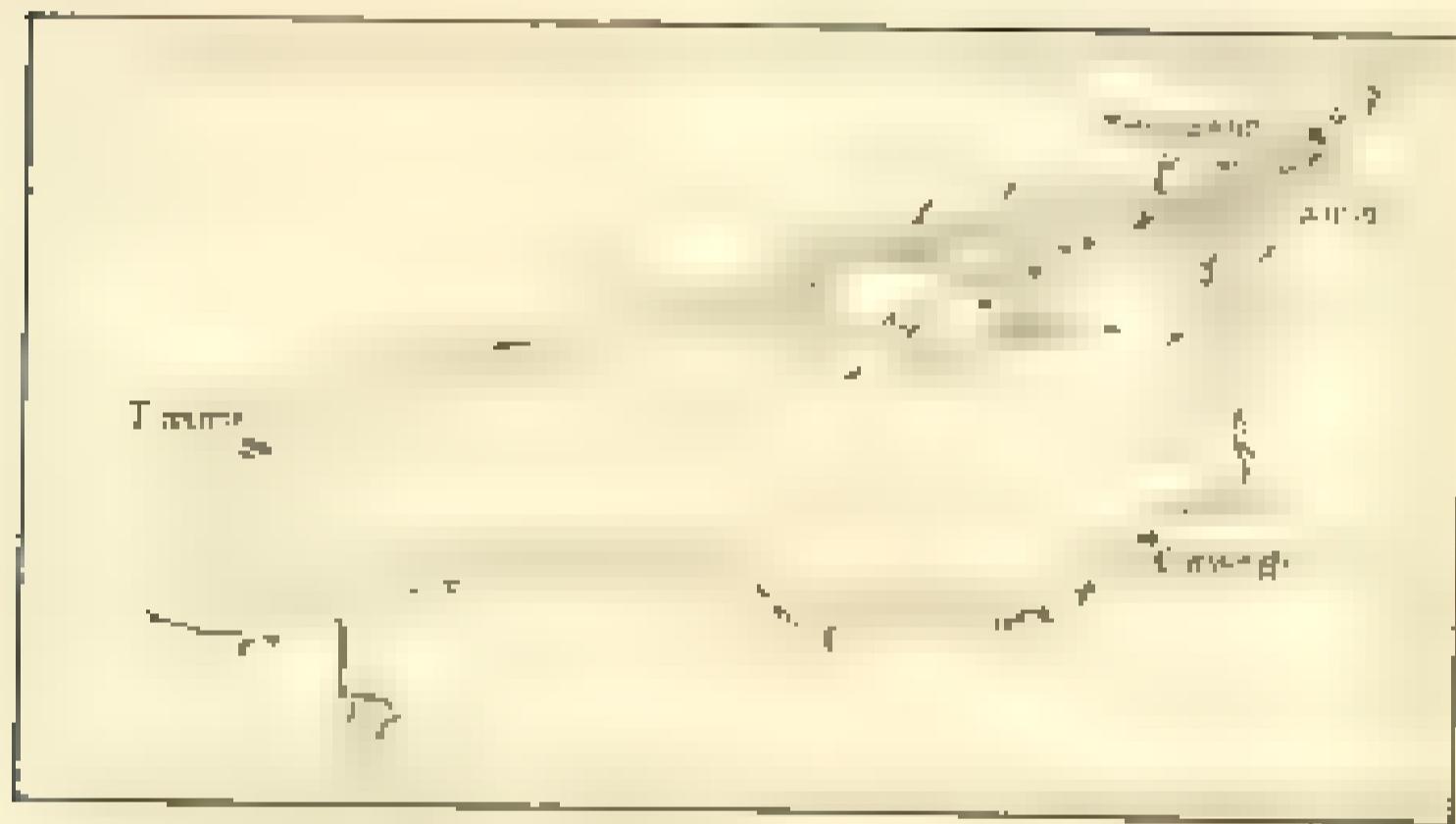
site has present only of Erie, and it was least one-third as large as the modern lake. Some that time the land has gradually risen, at the south, causing the basin toward the east, and the

dated by another flood line.





larging the expanse of the lake.



The broken dam shows the original extent of the lake.

There is reason however to think that the upper lakes, Huron, Michigan, and Superior were at first open to the sea, so as to constitute a gulf; but that eventually as more and more land was won, the natural drainage condition was established.

At the time of the great inundation of 1847, the lake had almost reached the level of Lake Ontario, but stood slightly above the

present water surface. It has been estimated at thirty feet.

has a remarkably uniform depth of seven feet or more, in a so-called northwest direction, or more exactly, S. 27° W. As will be seen

the surface of Lake Michigan near Green Bay, and below the



FIG. 4.—THE BEAVER ISLAND BREAKWATER.
THE BOUNDARIES ARE SHOWN BY THE BROKEN LINE.

surface of Lake Huron just north of Mackinaw Bay. The southward tilting of the land, involving the effect of the point of

down and the water overtopping the structure and then

then subsiding and a读ularance of the uplift caused the

ing the St. Marys river, also extensive, and eventually the present connection was made.

of the Niagara river east to Niagara falls, estimates based on the erosion of the gorge by the water, run up, that to the lake Erie was excreted approximately as long as the Niagara river, and hence about probably by rock eroded in tens of thousands or hundreds of thousand years. Lake Ontario is taken younger, and that can be said of, or long as Great Lakes disappearing in that it came along after the disappearance of Lake Erie, but the date of its coming, through the transfer of water from the Mackinac to the St. Clair, is more difficultly known. That event is estimated by Taylor to have occurred between 500 and 1,000 years ago.*

The lake history last briefly sketched is characterized by a progressive change in the altitude of the land there, others, and a characteristic portion of the region bordering the Great Lakes turns to a western course and moves toward the southwest. The last change, from Great Lakes Superior to Great Lakes Superior Michigan, at Huron, is rising so rapidly the period of more than 400 feet, has taken place within so short a period that we are naturally led to inquire now whether it has yet ended. Is it still probable that the land is at present at the height of 1,000 feet above the sea? Long ago it was so at the shores? J. W. Snyder, who has been an active ex-Jones River engineer and the general lakes and Lake von Trapp, says to readers particularly, as of opinion that the movements are not over, he, and, predicts that they will result in the restoration of the Chagooon Lake of Lake Huron and the drying of Superior.

The importance of testing this question by actual measurement has been appreciated by a few men of sound judgment. Such a laborious set of observations is however costly. Existing in this, I collected a few years ago a number of charts, which began with the exhibition of existing reports of a height as recorded by given readings, and was soon found by the establishment of a committee of government in 1876. To identify it fully the following measures which it is necessary to consider the author of that action for it is difficult to give them to what the lake water is subject.

* The "Great Lakes Conference," A short history of the Great Lakes, 1876.

John T. Moore

If the volume of a lake were invariant, and if the water were in perfect equilibrium or gravity, the surface would be constant and a level, at $\frac{1}{3}$ the elevation of the changes in the height of the land could be easily determined by observing the position of the water surface with reference to the land, but these conditions are never realized in the case of the Great Lakes, where the water is continually running off these lakes probably at the rate of $\frac{1}{2}$ foot a minute, in effect of such changes.

Causes for first the fluctuation of water. The friction of the wind on the water produces waves. These are too temporary and too factitious to speak of much, but the continual ground swell of the ocean is not unknown in the lakes. The friction of the wind on the water also drives the water forward, producing currents. The water thus driven against the other part of the lake in order to oppose the internal action of the water resists the flow, the return, and there is consequently a heaving of the water. Gusts of wind also produce a corresponding lowering of its level on shores. There is great evidence that a storm wave raised to several feet, reaching a maximum in Lake Erie, in October, 1850, a westerly gale is reported to have raised the water 8 feet

changes of level are much smaller, but they are more or less approximate, and they have often been detected in the case of the great lakes. "Land and sea" breezes which in calm weather are generated by the diurnal cycle of winds, where can be seen on the lake.

The water is always said to be isobaric pressure. If the air pressure equally on all parts of the lake surface the atmospheric pressure of the water would be uniform; but the pressure is not uniform. As shown by the isobars on the hydrography chart, there are points of difference of pressure from point to point, so that the height of the Lake Erie Lakes above the adjacent several feet of a barometer will be 10 inches for every 1 inch high we go as a column of water 13 inches high; and when over the atmosphere pressure at one part of a lake, currents express themselves either by the bottom of a barometer touching water below at the first part of the current, or to 13 inches lower than the water level at the second part. Wind is another cause of a change of level, but it is not caused by the

*See also Vol. II, pp. 24, 26. The effect of a sudden rise of water in lakes observed about the time of the great flood of December, 1842, see the part 2, pp. 26-28.

the wind observes much sudden and temporary variation of

the wind, except that they are broad and low, and these waves
only travel small parts of a lake but are continued by reflec-
tions, so that it is evident no percept is felt on the water surface

for miles and for a considerable portion. The passage of the
strongest winds here waves associated with ordinary cyclone
storms on the lake, especially when they are also in the south-
west body of the lake in summer, so that it always continues to
rise or fall to near lake level, drawing water in a lake or basin, and
these varying motions are of little importance. In the

case to be set over the intervals of the highest to the lowest. Such

variations between them, are called *surges*. The same blade is
usually a few inches, but at the ends of lakes is sometimes
several feet.

The lakes, like the oceans, are served by the attractions of the
sun and moon. The tides are in each case of short
period, and are even small as compared to the oceans, but they
are still considerable. At Milwaukee there is little
more than an inch and three quarters at tide a half stroke. At Chicago
and Duluth the variation rises to an inch and a half, and their
contribution at noon or at full moon to these inches.

Water is continually added to each lake by rivers and creeks,
but the rate is not uniform. Usually a few freshets occurring
within two or three weeks contribute more water, than comes
during all the remainder of the year. Water is also added in an
irregular way by man and animals falling directly on the lake. It
is not hard to compute, on the rate of evaporation, and
it overall will not varies within its extreme limits. The type
of water contributed to the lake, owing to precipitation
rain and snow, is less. Whether Lake Erie gives the gulf of
Lac St. Louis the reforming areas. In twelve years the
variation for Lake Superior is 12 inches; for Lakes Michigan
and Huron, 13 inches; for Lake Erie, 14 inches, and for Lake
Ontario, 15 inches. Low water occurs naturally in January or
February for all the lakes except Superior, where it comes in
March. High water is general winter in the lower lakes, June

being the usual month for the no. June or July for Lake Michigan and Huron, and August or Sept. on, for Lake Superior.

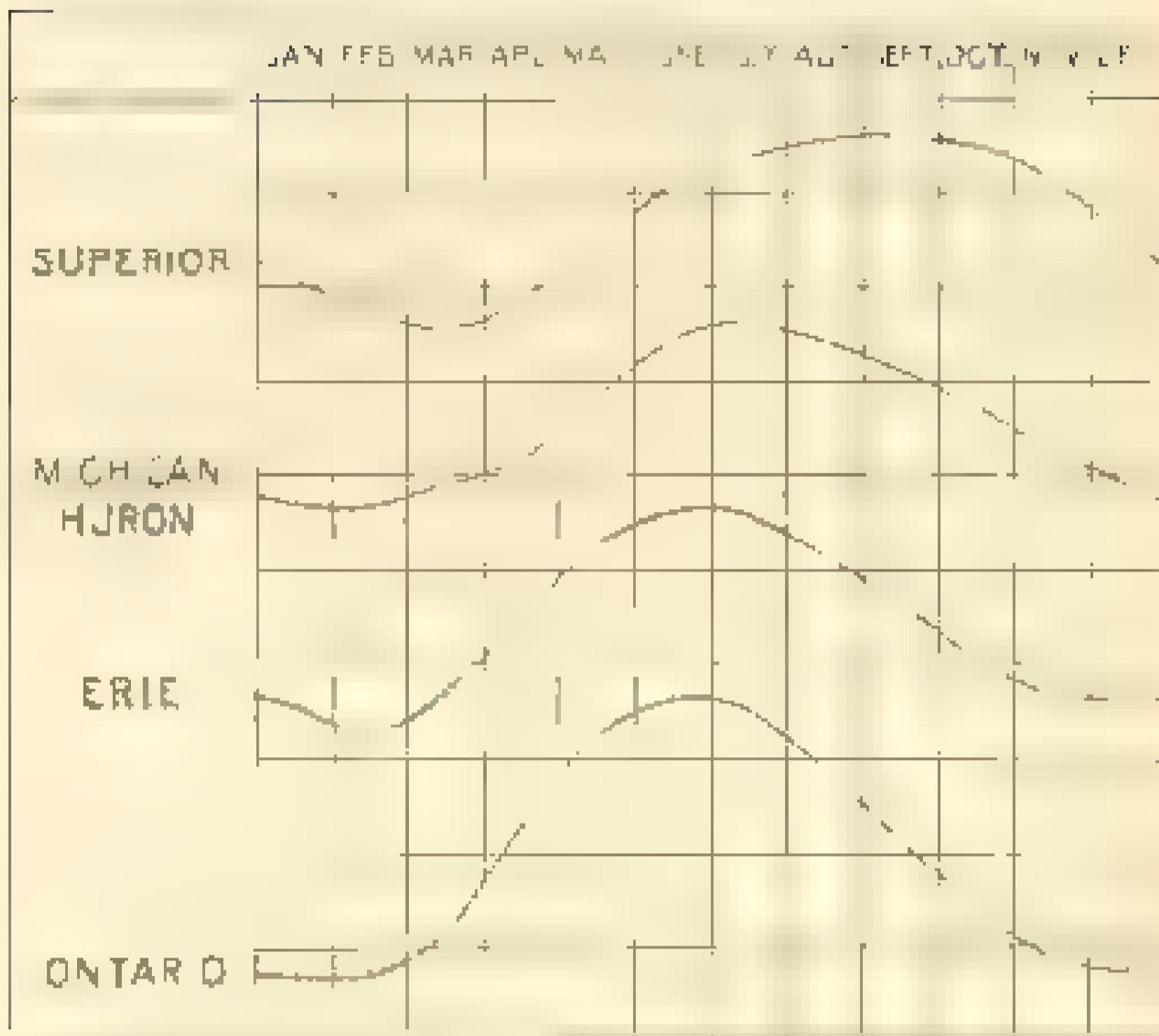
Fig. 4 shows the character of the current from above, as given by averages of long series of years.

In several years there is a current in the lake, and always a drift there is a current. The purpose of a dry year there is a drift and a series of wet years (including 1874) a steady high water, and a series of dry years (especially now), so that the drift to the west of Water Levee, Muskegon, is probably greater than the annual range. The recorded range for Lakes Superior, Michigan, and Huron is between 6 and 8 feet, for Erie and Ontario, between 1 and 5 feet.

The lower part of diagram (Fig. 5) of the section of Lake Michigan, an undrained lake in most years and nearly a perfect reservoir of the north western part. It may be calculated from monthly means of precipitation, and does not allow for losses due to evaporation, and for short periods.

The various calculations of the water budget differing widely in respects to rate, and cause, yet coexist, and they make the actual movement of the water extremely highly variable. The actual quantity of water held seems to increase with the rise of the water place as it does in level for the mass removal of earth from side, but a system of calculations of that is impossible, and will therefore leave the main problem of such a system, higher, but still to a large extent to be solved. How important is not the direct measurement of the magnitude of independent factors! not to mention other but more permanent ones! always be true to whom two in one, & our sensitive heart being measured by means of the water surface when the water and atmosphere

WATER LEVELS OF THE LAKES



A copy of this under the direction of the State of Minnesota, U. S. A., from time to time
made at Milwaukee, Wisconsin, Great Lakes, etc., in Lake Superior, Lake Michigan, Lake Huron,
Lake Erie, and Lake Ontario, during each year, with vertical scales in feet.

In the diagram, Fig. 8, A is the profile of a lake but L
and O are both 100,000 cubic feet of water, and we suppose
the water surface to have the position A X'. According
to the water in equilibrium, all parts of the surface are the
same, i.e. If the part of A above the water at X be accurately
measured by the altimeter & level, and the part of B below the
water at X be similarly measured, then the difference
between the two quantities is given by the formula with the right conditions
A - B. After six thousand or 6,000 years of weathering the work

Y' V, and the length between the date of A above Y and of B below

the height of A and B, and if earth movement has not led the two stations A or B, the change in our relative height may be shown by the difference in the two measures of displacement.

As the water is not yet at 1,000 ft. corrected height on the Great Lakes, a set of lines of level from A and B to water was not obtained, and it is necessary to determine from a record made on the day of low water surface what would be the position if such a record had been made by means of gages. If one or zero, place by the water, and a point stated again by means of which the vertical distance of low water is made from the zero is given.

Changes in the volume of the lake obtained all parts of the lake to be investigated it is only necessary that the gauge observation of a at the two lakes be known in advance. The other found water can be determined by breakwaters. Estimation is to be

made when C is low. The effects of lift will have to be approximately eliminated by taking the average of many observations, and so can be effects of subsides and tides. The effects of all forms of atmospheric pressure on the earth caused from barometric inappreciable at a pressure, and the pressure of wind and displacement exist in both directions and to either side and a downward up by corrections and the wind and sea current effect may be taken in like an no way.

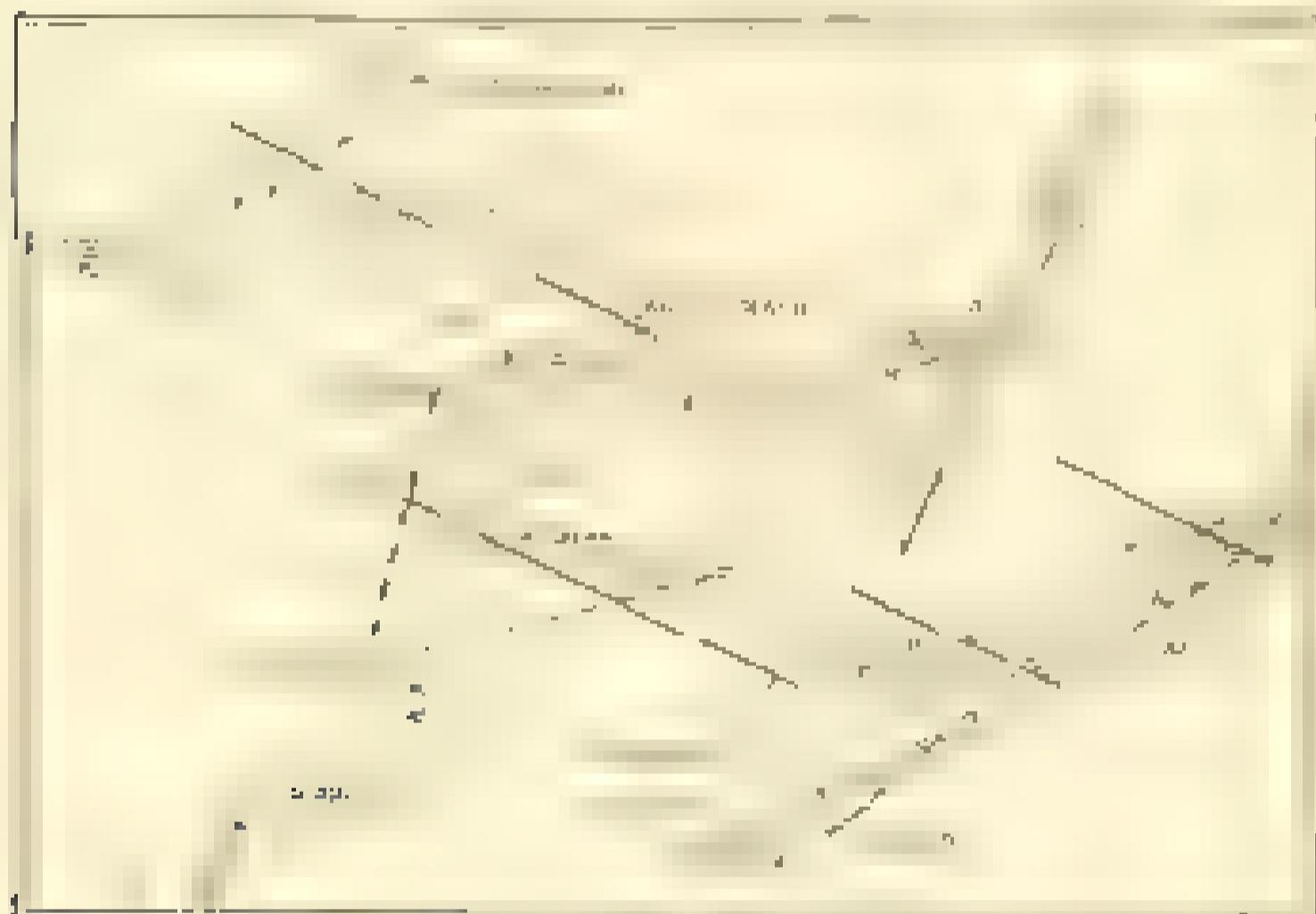
In the experiments I was able to make conclusion was given to these various causes of error until was not practical to take up. Since the correction for a change in elevation from the reading of gages was only partly under my control. Gage stations have been established in front of houses at various times at flat various places, and the result of readings have been forwarded. In some cases the reading of gages were corroborated by having with them marks of a permanent character, and for a few the

most important of information of its character is communication to the bureaus of the United States Lake Survey, where were placed later service of the Office of Engineers, U. S. Army

equivalent to A and B of the column and have previously determined the identity of the two years ago. At some of these stations

it was necessary to connect them with the old ones. At all of them observations were made from July to the first of October, 1880, and these observations, in connection with the tide levelings described previously, could be compared with those made early in so as to determine whether they had to be carried forward or not.

It would be necessary to give here the details of observation and computation, as they were fully set forth in a paper given to



The additions may consist of the three broken lines shown the same as the original survey, but the general course of the work may be readily outlined. As the figure shown by the suggestion, it is intended to test the sections of the lake, in that direction. The most easterly part were marked a Harbor on Lake Ontario New York, connected by a narrow isthmus of Lake Ontario (see map, Fig. 7). From observations by the U. S. Lake Survey in 1874 it is proposed that a mark on the line of light-house on Grand Island has been 18.51 feet above a vertical junction line. This is to give an average of three feet.

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at the head of the Saginaw canal, as compared to a point 16 feet above at Olds, about 230 foot, or nearly three inches. Between 1850 and 1870 it rose to Port Austin, Michigan, on the shores of

of Lake Michigan, rose 4.17 foot, or one and one-half inches, and in the same period it rose at Escanaba on the west end of Lake Huron, 18.4 feet, as compared to the same point in Milwaukee, Wisconsin, 18.0 feet, or about two inches.

The following is a rough estimate of the change that is now from doubtless, changes in other stations on which there were no marks that have settled. It should may have been made in the air, or even in water. There was no object of support by the rock, so as to allow of a test, and there are various other possible sources of error to which no checks can be applied, so the fact that all the measurements indicate rising water I consider it is recorded by history deserves confidence in most verdicts. This consideration is particularly strong when the different results are reduced to a common basis and compared.

Approximate Dates & Times, Elevation, and Movements of the Great Lakes

	$\frac{1}{2} \text{ sec}$	$\frac{1}{4} \text{ sec}$	$\frac{1}{2} \text{ sec}$	$\frac{1}{4} \text{ sec}$	$\frac{1}{2} \text{ sec}$	$\frac{1}{4} \text{ sec}$	$\frac{1}{2} \text{ sec}$
	$\frac{E}{2}$	$\frac{E}{4}$	$\frac{E}{2}$	$\frac{E}{4}$	$\frac{E}{2}$	$\frac{E}{4}$	$\frac{E}{2}$
Mov.	M. m.						
Saginaw Harbor and Canal	1850	1860	1870	1880	1890	1897	1900
Port Austin and Milwaukee	1850	1860	1870	1880	1890	1897	1900

The stations of the several points are at a different elevation, and the surveying of the lake commences them in the same angles with the theoretic direction of sailing, and the same intervals

apply here in the elevated direction, &c., 27° W. In the north end of

length of the code of a line 14 miles long down up a cataract.

Calculated in this way, the results are remarkably exact indeed. The comparison ratios of the lake varying only from 0.97 foot to 0.98

here & there a record of the surveying of the Grand Lake-hunting ground.

It is first

done

beginning on which basis it is done very well by measurement along the great art. It is proper to note that the fundamental idea was introduced much earlier by G. R. Stantz, a Wisconsin surveyor. In a paper communicated to the American Association for the Advancement of Science in 1850 he gives directions

and apparently based on the west end which it was to measure low at the east, and he infers that the end is not stable.

I

to the north. All points southwest of it are lowered, those to the northeast are raised. The water, always following the surface, exerts always a regulation of volume by the discharge at

Change

Lake Ontario has altogether submitted to the incuse of the water, and the water is encroaching on its shores. The water

Sapemuska lower 5 or 6 inches per century

the consequent apparent lowering of the water surface is for the mouth of the French river on Chippewa bay. In Lake

Michigan the estimated loss of the water is 4 inches per century, at Milwaukee no estimated rise is 6 inches, and at Chicago between 8 and 10 inches.

These slow changes of mean water level are concurrent from time to time, but they are worthy of comparison to a large community. The city of Chicago is but one example of jettisoning and comparatively delimiting

Looking to the north and south we may estimate the late glacial period at about 10,000 years. The land, as it really remained, is an old chain of hills bounded by the outlet of a glacial lake. The bed of the channel at the summit of the pass is about 3 feet above the present level of Lake Michigan and 5 feet below the highest level. In 5000 years

it will be continued. In about 20,000 years the Mississippi will have reached the western outlet of Lake Michigan. In 20,000 years the Niagara river will have become an outlet of Lake Ontario. In 50,000 years a sea water will have been diverted to the Gulf of Mexico.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

If the British Association for the Advancement of Science has honored you, come itself the honor of electing a geologist, let me assure the President, it at least is not open to the reproach of being set up to represent a department of knowledge as that which is important or of interest. It is of great importance and the chief condition of its encouragement. Throughout its history of 7 years the Association, as great geographers as any men now living, have been few but distinguished explorers who have had many interesting and

valuable lands. Just 40 years ago, in the city of Edinburgh, it was to see and hear Lyell's doctrine that people crowded into the Hall assigned to Section E. Fifteen years after, at Brighton, before an audience of large and brilliant assembly, Mr. Broome narrated the惊异 story of his search for the great meteorite-dweller in the Woods of equatorial Africa, and almost every Arctic ex-

THE BRITISH ASSOCIATION

LEADS AND DISCUSSIONS BEFORE THE LONDON ASSOCIATION.

If the recent Toronto meeting were to be recommended for any

prudent acceptance geographically speaking. The business of the

with the geographic problems of the future and act for the advancement

remote parts of the world.

Dr Keeling's address was delivered on August 10, and in the afternoon, at London, presented his sixth report of the Committee

Mr G. Delmar Moreau, of London, read a paper on Devon Quan-

tum bounded a paper by Prof. Richard E. Dodge, of the University

A paper by Mr E. G. Ravenhill on 'The Relation of the Earth's Magnetic Field to the Sun'.

July and August lectures of the Geographical Institute.

Biology of the United States.

of London, and The Director of Taxes of Structure in Harvard.

Shortly after the escape of its number

Mr. A. C. Harvard, spoke on the importance of geography as a

illustrative of geographic sections and conditions.

meeting. In the Section of Mathematics and Physics, on August

and marine column. On the 21st of day, in the lecture of Geology,

Mr. A. G. Agassiz, in the Section of Mathematics and Physics, left

which the Regent offers to Geologists and Naturalists.

In the Section of Meteorology, on August 21st, Mr. J. D. Hooker

THE CHAMPION ATLAS ON THE EARTH'S SURFACE 251

London, January 21st, 1866.

To the geographer, especially on August 23, when the promised

Contest, opened by Prof. F. W. Putnam, of Harvard

and are of greatest value and are available for the purpose.

THE CHAMPION ATLAS ON THE EARTH'S
SURFACE AWAITING THE EXPLORER AND
GEOGRAPHER*

By J. Scott Keltin, LL. D.

Secretary to the Royal Geographical Society, Editor of the Geographical Journal
and of the Student's Text-Book, etc., etc.

We know that you will except our congratulations. The reason

of our doing so will be clear from the following

* Communicated at the Annual Conference (Geographical Section) of the British Association for the Advancement of Science, at Toronto, August 18, 1865.

THE EXPANDED AREA OF THE BRITISH EMPIRE

In past we have all of us been celebrating the sixtieth year
of the reign of the King and the fiftieth Kingdom from internal peace. The pro-
mote for the expansion of the globe.

most all we have been made to our knowings the trial of
the character of that ancient world sixty years ago of the most

united. And I entered you of the present progress which has

now come to our shores and spiced up innumerable flocks of
people.

I have thought, then, that the most useful and most manage-
able will be as to do the following

claim. Since then the entry of [in] the of the greatest

undertaken undertaken by any State, has been completed, as is

THE INHABITANTS OF SOUTHERN I.

The most important dependency, so far as pioneer civilization in Asia is concerned, may be said to be confined to two regions—the North and South America. There are tracts which are

as great as a sandy desert. At the same time it is, in the extent of rich vegetation and whose climate the late Mr. Brewster has

described, and indigenous—which might be met with in another interesting story

one month and next. Lines of civilization have, in recent years

extended, Welby and Macmillan. From the results obtained by scholars we have formed a belief of this the most ex-

treme, rugged, and the most inhospitable land in the world. A

most interesting feature as to the geological history

THE PIRATE CITY

The town lying to the port of the Huon River range and to the sea is the port of Iloca, or almost a blank on the map, and there is ample room here for the enterprising pioneer. The neighboring city of Coquimbo at present the goal of several adven-

turers, though as a matter of fact we can not have much to learn in addition to what has been related in the interesting narra-

tives of the native Indian traveler, Chumico Paez. The maps of

THE CHINESE RIVERS ON THE EARTH'S SURFACE

and mountain region on the north and east. I have mentioned

"

already that it from the east, through Szechuan, another branch of the Colorado descends into the intervening plain. Mongolian inhabitants live here as with a strong desire to leave home. On the southwest of Tibet is the remarkable mountainous region, consisting of a series of nearly parallel chains, through which flow the upper waters of the Yenisei, the Irtysh, the Irtish, and the

probably does not reach far into the range. but it will be probably a glance at a map that the upper waters of the other rivers are carried far into the heart of the mountains. but these upper

countries. There is plenty of work here for the explorer though the difficulties physical and political are great.

But next to these great mountain regions there are many banks to the S and SE the outer parts of the Tibetan region which,

as we know, are almost uninhabited, and that at no very remote period, to almost surrounded by the Tianshan, and on its eastern or gelid

shore. Very much inhabited, and that at no very remote period, to almost surrounded by the Tianshan, and on its eastern or gelid

of recent development. As regards of Dr. Nansen's Voyage of the Fram we will take the results as they stand perfectly accepted. Of course it is a difficult task, but it is one in which the Russian government ought to excel. The map on paper

such our knowledge of its coast line, the great number of the great rivers is to a large extent extremely vague. All the main streams have been surveyed. In Southwestern Manchuria and in many parts of

other systems to be surveyed. In the Many provinces and in the great array of islands in the coast of Southern Korea, Southern Japan, the Philipines—much work still remains to be done. Thus for the coast of China there can be no doubt of

THE NEW SPED SUEK ON THE PARTS OF AFRICA 27

work for exploration is vast and plenty of interest to meet by the attention of our geologic herds.

CHAPTER VIII

Coming back to Africa, we find the most interesting trans-tropic work during the last sixty years, and probably during the last forty years, being from Liverpool an exploring party across the continent. Though the north of Africa was the home of one of the earliest civilizations, and though on the shores of the Mediterranean Plateau the Carthaginians, Carthage the Hebrews, and Romans were at work for centuries, it must be seen with other territory of many of what all the sons of the continent, from the Sahara to the Cape Horn, especially the latter, have been unexplored land. This task has been filled up with a well-chosen party. Great rivers and lakes and mountains have been run up and down in the two instances, and the whole continent, with a few ill-expected exceptions, has been passed over, giving the picture of harpoons but marks still remaining to be made up we can form an idea, with regard to what is in some respects the most interesting part the north or east side of the continent. Many curious problems still remain to be solved. The pioneer work of exploration has been largely done and accomplished. Lines have been run in all directions; the result is that trees have been blazed out, but between them the old and ancient woods remain as we find them, and to do this is to be the only way of real exploration. However, there will remain one or two regions that afford scope for some frontier exploration.

Just to south of Abyssinia and to the west and northwest of Lake Tana off into the Upper Nile, is a region of considerable extent, which is a junction of two great African rivers, the western Shambu and the eastern Tekech, which is also joined by the upper of the Tekeches, flowing with no other number to allow its name, and which is to our knowledge extremely scanty. Even in the eastern Shambu there are great areas which have not been traversed, while in the last named there is found no timber, and you could stand on its banks and deserve entitled the best position, not only than we may have ascertain before that project comes, but in view of a sea, till we may try to compare and adduce to the past history of the northern big continent. Still, I trust I record that the great features of the continent have been as fully explored during the last half century than what is required now.

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"THE UNKNOWN ARKS OF THE EARTH AND SEA"

is usually the blight of science. It is in a process but re-

quires a long time to ripen. Quite recently the English traveler Mr Cooper found not far from

or our maps. If only the obstinate vanity of the Turkish officials could be overcome, there is a rich harvest for any one who would go to work with patience and intelligence. Even the sailors of

The Ferganæ in both Tibet and Abyssinia have examples of known knowledge which may be added.

MAPS FOR THE TRAVELER

are doing much to acquire a knowledge of their territories. Our

The famous, the Shire, and the craters of Lake Tanganyika. Just now

and the map of Africa is being gradually filled up. But what

would work on the Great Rift valley is one of the most valuable contributions to African geography ever made. If any of these streams would settle down in regions like that of Mount Hawes or Lake Rudolf or the region about Lake Ngamiwe and

I think the game created in geography, as well as to the economic interests of Africa, would be great. An example of work of this kind is seen in the observations made by a young biologist turned to gamekeeper, Mr Moore, on Lake Tan-

Mr Moore's habitat is essentially of a salt-water type. Mr Moore, I am sure, is just as fond of the land but the greater connection of this part of Africa with the sea was not by the west as by the north. This point suggested, but by the south, through a careful examination of fauna which are the general test of his

holy to pray, do few things of the highest importance.

CLIMATE IN THE TROPICS

But, there are other aspects of problems connected with this con-

sideration of Africa, like the problem of acclimatization. This

is here of the first importance. We know that Central Africa has many potentialities, and thereof we will look forward to the exact results to pass. We can only go to work experience daily until we know and solve the problem of acclimatization. It is when we have the exact facts,

the opinions of those who have had long experience of African

work in tropical Africa, it will never be possible to estimate

Conclusion

Up to now, most, and especially here at home that white people generally hope to settle in Central Africa as they have settled in Canada and the United States and in Australia, and make it a home and a home for new generations. Here in South Africa we understand that not be raised over a certain age, they must be sent to school. No country can ever succeed the true home of a people if the children have to be sent away to be taught. Still, it is true that experience in Africa is limited. It has been maintained that it may not be possible to add to Europe as its home land

28 THE TRAPPED ARE IN THE FIRST SIGHT

Afrope by a prudential course of migration. This may not only serve

to inflict still further suffering here in the country, but to keep up, though one it would be, might be tried, but do it by force, constant annihilation, even of the more developed of those characteristics which have made Europe what it is.

In this young Italian physician, Dr Sammone, we recently

finds that it has taken up residence in Europe to observe our Industrial evolution, the progress of the various industries to which Northern humanity is a prey, and to meet them also, or rather than. In Africa we have a totally different set of conditions to

produce such forms of malaria, anthrax, and other diseases characteristic of tropical countries. The result that these are now or will be to lead, to the nature of the soil, and other the principles of working we should be in a position to meet them and

The following proposed form. What is wanted is a series of carefully conducted experiments.

I have referred to the Manzano highlands. In New Mexico

above sea level. The world may become so full that it may be forced to migrate there. By improved means no homes for

long, however, probably. As one of my physician friends in New Mexico (Mr. R. M. Johnson) tried to show at the last International Congress, the population of the world will have more than doubled in a century, probably in 180 years hence will have quadrupled. At any rate, there is a probability of great migration for the greater part of the coming century in attack. We do not yet understand what manner over Africa. It could not be difficult to obtain the data which might be passed toward the south on

S. J. THOMAS.

I have dwelt thus long on Africa, because it will readily be one of the great geographical problems of the coming century. Had there been substance no America or Australia, we may be sure it would not have remained so long unaffected and unexplored by the European geographers as it has done. Content mostly for Africa, just as it had been everywhere else, and just as its peoples were the way into the interior Columbus and Cabot discontinued it now not to be faced. That old country disappears far back into antiquity.

With regard to the exploration of Africa, which has been known to Europe so long before the beginning of history. During these four years North America at least has been very thoroughly explored. The two great nations which invade North America are not only interested in the results of the geography, but especially in the natural resources.

I do by the survey of Canada under Sir Wm. G. Logan, for many years his engineer. Dr Dawson has said in his foreword that under the late department there, except to

the predominance of the, though there has been many, larger regions to be found. There are large areas which have not as yet been thoroughly mapped. Within a single recent year we have and have now observed as to be by the work of Dawson & Ig. D. on the Yukon, Dr Bond in the region to the south of Upland Bay, by the brother of Tyrell in the Larrago lakes on the west of the same bay, by others from beyond the shores of the Okanagan and by Lewis in Eastern

but it is not so long since that Dr Dawson, in review the work performed to be done in the Dominion in the way of even partial exploration pointed out that nothing like a full or accurate map of the continent to be mapped. Apart from the fact that where regions in the north, there are no Dr Dawson performed over considerable areas which may be to a small proportion of the total land area of the continent of which we know little good areas as those which have been thoroughly surveyed and triangulated. It is

200 THE CHARTER AND ACTS IN THE FIELD SURVEY

so far by the Geological Survey of Canada by Mr. Franklin.

no such ultimate intention. A very great deal has been done for the survey of the rivers and lakes of Canada. I need only say

that at any of my journeys in physical geography — east and

west — I have been to the rivers, the lakes, and the coast. Large & both in Canada and the United States there are

no publications in this direction, but a ready accumulation of literature, both in Canada and the United States will be found

UNITED STATES

Every geologist and geographer knows the important work which has been done by the various surveys of the United States, as well as by the various state surveys. The

Geodetic Survey did only the coast but all the navigation between. The Lake Survey was not doing a similar service for the shores of the Great Lakes of North America. But it is the work of the Geological Survey which is best known to geographers — a survey which is really complete, and as well as possible, and which under such a name has flourished, having a few years

ago, been placed on a more systematic basis, so that a scheme for the topographical survey of the whole of the last century of the United States is being carried out. Unfortunately certain parts of the States are being rapidly surveyed in different systems. It is to be hoped that in the future, as in the past, the public interest also engendered in this survey work will have its result in working out the physiography of each of the various parts of the continent. Of the complete exploration and mapping of the North American continent we need have no apprehension; it is only a question of time, and it is to be hoped that number of the great cuts made will now prevent

THE CHIEF RIVERS OF THE EARTH AND THEIR INFLUENCES

by portland.

PORTLAND IN SOUTH AMERICA

It is when we come to Central and South America that we find ample room for the most valuable explorations. In Mexico and the Central American States there are considerable areas of which we have little or only the vaguest knowledge. In South America there is really more need now for the pioneer explorer than anywhere in Central Africa. In recent years the Argentine Republic has won territories, which in certain respects of great work has been done by its

early explorers. Along the great river courses our knowledge is

fairly good, especially the rivers Paraná and the Amazon. In Par-

aguay and the Rio Negro we have time to return, walk on the West Coast

of South America, and explore the rivers of the interior. In Brazil

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now we ought to be able to bring out a satisfactory information on the geography of the country traversed, and of its fauna and flora.

Fourteen thousand feet above sea level there are of the highest interest. Moreover, we have here the remains of ancient civilisation to be studied with repay careful investigation.

ABSTRACT

The most recent continent of Australia is in the hands of men of the native origin or ancestry who have developed to a high degree the characteristics of their race in it. The five columns which follow show the following the 1,000,000 square miles of the continent.

of the country & character suitable to agriculture; in all areas

able. This desert area has been occupied by explorers at the ex-

istence with spadix and scrub where none needed. There are

1,000 species of plants from time when, have been found along the routes that have been explored.

More than four years that have connected us with the world

and for the richest results in botany. These remain to be

for water as an immediate source of water. In one or two places in
valleys, the supply was soon tapped with satisfactory results;

ALASKA

PLAN OF EXPLORATION

In North America—so far, at least, as the Old World side of the Polar circle is concerned. That some day will reach the Pole at the earliest will be clear. Nansen has shown the way, and the vigilance of humanity will not rest satisfied till it is goal is reached. But first a question does not rest with the attainment of the Pole. Europe has another claim on her own side of the Pole, what about the side which forms the hinter-

lands, Prins Josef Land, Nova Zembla, and the New Siberian islands. To the west of Asia we have an immense area, the actual extent of which is unknown. Nansen did

so far that half of the North Polar region what Nansen has done

THE DEVELOPED AREAS OF THE EAST'S TRADE

than than we find it out on our maps. Whatever be the case, it is important in the interests of science, that this section of the

world's trade - all round the globe.

It is stated that our gallant Lieutenant Frobisher has organ and a
wonderful task. Let us hope that he will be able to carry out his
ambitions. Mean time, whilst Canada looks with indifference,
she has attained the standing of a great and powerful nation.
She has shown the most commendable zeal in the exploration

of other countries. Her press is of a high order, and she
has made the bug an ips of a literature and an art of her own.

In my judgment there is nothing of Great Britain so monstrous
than those enterprises which have been carried out from

up between her and the Post I venture to throw out these
humble and glory of the great Canadian Post.

THE EAST AS AN INDEPENDENT STATE

Not only has an interest in Arctic exploration been revived,
but in Europe at least an even greater interest has grown up in
the exploration of the regions around the opposite pole of the
earth of which our knowledge is so scanty. Since our friend

and writer in history, Baron von Hammer-Purgstall, surrounded the
North Pole. Instead of an almost solid continent, it is believed

now that it is true we have a fairly adequate idea of what

THE CHIEF PROBLEMS OF THE EARTH & MOUNTAINS. 20

are the real extremes. We want to know what is the extent of that land, what are the glacial or old areas, what is the character of its geology, what evidence exists as to its position, and especially the conditions in post ages? We know there is one lofty, active volcano. Are there any others? Moreover the question of terrestrial magnetism is extremely important to the practical navigator the data which we get from the Antarctic are so exact & so few around it is difficult to determine the magnetic field as to (east & west), their temperature, and their life. We have here, I say it, the most extensive, unexplored area on the surface of the globe.

plete the work begun by Scoresby forty years ago, and to an extension

of just all enterprise which might involve the services of a few naval officers and men. We need not estimate this latter; but

expended upon for no Antarctic expedition under such circumstances. It is felt that Antarctic exploration is peculiarly the

task of one of the greatest geographical problems of the future,

to say. It may be mentioned that a small and well-organized

affair at a larger scale.

With our opinion has to be had not only with the lands of the

South in those, so far as some as Patagonia is concerned. The importance of navigation, by a country advantage over another, in

Indeed it may be said to have come definitely into being with the famous voyage of the *Challenger*. There had been calculations for oceanic magnetism before that, but on a very limited scale.

In 1861 Brown, 1 and we have been able to obtain an account of the results of the expedition of the *Challenger*, 2 of the magnetic field and of the composition of the sediment which covers it. 3

The extent of the knowledge may be gauged by the following:

It took Dr J. A. Marconi twenty years to bring out.

Whatever is due to the open, belongs to the mind. It is only the extent in they deserve.

They have generally been the subject of special investigations—
mainly for special English river systems. The work in the Far

East has been done by the German government in the given

Lawrence's *Journal* (which an official publication,

THE COMPASS IN MODERN NAVIGATION

by G. W. LITTLEHAWN.

F. & G. Nodograph & Co.

TRANSPORTATION, navigation, with all that it has been to do with the rise of the world and the development of the civilization of

the extent of the influence of the compass, in important stories.

different strong magnetic disturbances, and truly, by the end of the eighteenth and sixteenth, to a lesser if less important than it was when it first came into existence, though still important. The latter disturbance is less powerful and its period longer. The former seems to produce but little if any effect, but it nevertheless has

over the upper surface.

In spite of all these steps to improvement of the parameters compass was still used as the surveyor's, being influenced by the earth's magnetism alone, but with the growth of time a graduation and index to the compass dial was found back every compass itself becomes a great magnet having nearly the same kind of force as the sun.

It is long been known that the earth's axis upon the longitudes of 0° and 180° is but a magnet line, and that it has definite poles of opposite strength having a magnetic field so strong that it which may be recognized in general by lines of magnetic intensity leading from one pole and proceeding to the other by

everywhere established lines. For more than a century it has been understood by geomagnetic relations to represent the elements of the earth's magnetism of the earth's magnetism as such being at the surface, by lines converging to be drawn to, or the surface of the globe. The lines pass up through all places where

parallel to the surface and of equal magnetic induction.

carried paths to the interior and through longitudinal poles of the earth. The lines which are supposed to be drawn through

lines of equal magnetic induction are called meridians. They grid the earth like the latitude lines parallel to the magnetic equator, but without the name of the parallels of longitude which are drawn through the geographical equator. The magnetic equator is the line passing through every point where the freely suspended needle lies in a horizontal plane. As we travel from the magnetic center towards the northern magnetic pole the need of inclines increases

turns, the north pole bending downwards until it becomes vertical, while the south pole remains in vertical direction. As we have mentioned, in other magnetometer poles the same takes place when the earth's end of the needle.

So far results may be obtained by current or induced winds that could interpret field of a baromagnet. At the central band

the earthward pole becomes more and more, so does with the baromagnet which gives a magnetic field that varies in intensity from point to point so with the earth's field magnetism is also powerful near the Poles and gradually diminishes in strength as the magnetic equator is approached. There is nothing gained or lost in the above. These are known as results in the first edition of our number I believe. In general, consider they is flow lines of equal induction or ϕ ,

or if you like to express it in another way by a belt and loops, where the values of the magnetic elements are not fixed either as to time or locality, they shift their position so early, early

and used to be indiscriminate, with the exception of the singular element, one of which stand upright while the other does not, in fact the compass on the seas where orientation is carried on.

It may be drawn so as to hold good for several years from a given epoch.

A firmly suspended magnet needle dipping nose down, everywhere except on the magnetic equator, is of no use. It is to you a ship. The compass need not be horizontal. The compass is not used to facilitate putting a nail and the nail need not be possible to overcome the downward pull of the earth's mass holding, or by shortening the compass and making of what is called a dipper. It is, therefore, only the vertical component of the earth's magnetism that gives stability to the needle of the compass and not a great deal more.

If a wooden staff will be no more useful than the copper or brass, were it not made of the wood, the compass would be quite useless. Large vertical phases last result from too much motion of the earth's magnetism a simple or less steady ones, according to

the ship herself would exert no influence whatever. But so to earth and ground, instead of passing a vessel having no magnetism to Idenes & Lutetia over the globe, a great magnet whose magnetic elements are known—the former's being the iron placed in passing a steel vessel, which is a great element, whose magnetic element is now over passing and passing over the globe, a greater magnet.

If a bar-magnet is brought in a horizontal position near a compass needle that has assumed a fixed position under the

guiding force sent from a magnet with the result that the magnet turns off toward the bar-magnet and with every

passage it will exhibit a new result of motion. I am inclined to the opinion of the magnetism of the earth and the sun, as well as the diurnal compass, or the influence of the sun is really complicated by the existence of a north pole permanent though it remains, of the ever-existing magnetism of the resulting from the inductive act upon the "soft" iron of the ship of the field of the earth's magnetism, and the ship permanent magnetism.

If a number of iron wrought iron that has not been heat treated and is not very free from magnetism be held vertically in our hand or the upper end rotated around a south, and it becomes a north pole. If it is reversed the same holds also, however, as that the upper and lower ends are still as they were before.

When that toward the south becomes a south pole, and when a real south or really in azimuth, the line of

that number which do I repeat, it can be the vertical as north指南针, and the facing the south by north compass. Again it is necessary that of a ship to be like the cylinder of iron wrought iron and as receptacle of magnetism to set on its being sloped over its ever-changing course as the cylinder is when turned into different positions. Then as the ship slopes more, in the other magnet of iron into the bow will become the pole of north polarity and the other

measured, so will the north force shift to the right in the antipodal direction.

Imagine a diagonal from starboard bow to port quarter. When the ship banks over to starboard she is polarized with south polarity, the port is a north, and the neutral line takes a general easterly deflection. Coming along to change course to the

new reciprocal, but this time it is the stern that is a north pole, while the bow is a south pole. At west the conditions of east

solitude of the just is to south polarity. And this transversal angle is to be the easterly and the ideal ship is a duly dexterous

leaving now the ideal or "soft" sailing and passing to the

characteristics that make it as portly and well defined as

MEASUREMENT OF THE POKERSHIP

An iron ship, with her square plating, decks, beams, girders,

timber and riveting, interfaces with the hull. However, analytical investigation is best applied to consider the ship empty mass. The effect may be considered as taking place at three

times all the structural mass of a ship is symmetrically pre-

found similarly disposed on the port side; and the problem is simplified to pairs of parallel forces, each pair having its resultant parallel to one of the coordinate axes. The effect of every magnetic particle, whether of permanent or induced magnetism, may be reduced to this condition. If the sum total of all the magnetic forces parallel to each coordinate axis be transferred to it, and the whole be conceived to be concentrated upon the north point of the compass-needle, the entire magnetic power of the ship may be computed to that of three imaginary compound-magnets—one laid horizontally in the axis of X; the second, also horizontally, in the axis of Y, and the third, vertically, in the axis of Z. By steaming around a circle in the open sea and observing the compass bearing of the sun with the ship's head on equidistant compass courses, and also, at the same times, the astronomical bearings of the sun, the magnetic effect of the ship—that is, of the three imaginary compound-magnets in the axes of X, Y, and Z—which causes the needle to deflect from the magnetic meridian by different angles at the different headings, can be immediately found, if the variation of the compass due to the geographical locality is known. As the ship makes a complete circle in azimuth, the north end of the needle is drawn sometimes to the right hand of the magnetic meridian and sometimes to the left hand; in the former case the deflection is called east deviation and in the latter west deviation. A table of these deflections, serially arranged, is called a table of deviations of the compass. The harmonic analysis of such a table of deviations consists in representing each of the elementary magnets, whose effects contribute to make up the imaginary compound-magnets, as a separate disturbing cause whose effect upon the compass needle may be represented by a constant multiplied by a simple harmonic function of the compass-azimuth of the ship's head. Adding together the effects of the different disturbing causes, thus represented, and placing them equal to the deviation observed on a certain heading of the ship, a conditional equation may be formed for each of the headings upon which the deviation was observed.

From such a series of conditional equations normal equations may be found by the method of least squares, and from them the harmonic constants which represent the elementary disturbing magnets. Thus it is that from the effect an intelligent comprehension of the cause may be gained.

With these coefficients a navigator may compute beforehand

the value of the deviation to which his compass will be subject on any heading of the ship; but in making long cruises and passing into different magnetic latitudes they require unceasing attention, because some of them represent the effects of the induction of the earth's magnetic field upon the "soft" iron of the ship, and as the ship sails the ocean she passes through ever-varying fields of terrestrial magnetism. Her own magnetism is also undergoing continual, though small, changes due to the writhing and straining of the ship by the action of the sea. Yet, by examining thoroughly into the harmonic coefficients and by considering the known values of the elements of the earth's magnetism, a careful navigator may predict a table of deviations for his ship and compass in any part of the world.

He will then understand and be prepared for such changes in the ship's magnetism as arise from the heeling of the ship, from change in geographical position, and from alteration in the course after the ship has remained for a long time on one heading, and he may navigate his vessel with the confidence and security that he would have in a wooden ship, for he can at any time correct the course steered by the compass so that the magnetic course actually made good may be laid down upon the chart or used in the calculation of the ship's reckoning, he can correct bearings of the land by the amount of deviation due to the direction of the ship's head at the time they were taken, and if he wishes to shape a course for a port, having found by calculation or from the chart the correct magnetic course to be made good, he can apply the deviations to obtain the compass course to be steered.

In many modern ships the deviations are largely reduced by introducing magnets into positions near the compass to compensate for the effects of the ship's magnetism. The analysis of the table of deviations shows that the polar forces acting in the ship may be represented by imaginary magnets, and it is, therefore, certain from well known laws of magnetic action that the effects of these disturbing forces may be neutralized by introducing real magnets whose forces have the same magnitudes but act in the opposite directions.

The proceedings of the British Association at Toronto were admirably reported by the local press, the daily reports of the *Globe*, together with a finely illustrated supplement, aggregating nearly 150 columns, or the equivalent of an octavo volume of 550 pages of long primer.

SEPTEMBER

SEPTEMBER

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—END—

Abridgments of the principal geographical papers
presented at the Toronto Meeting of the
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Science.